

The Homes and Social Habits of the Wood-Mouse
(*Peromyscus leucopus noveboracensis*)
in Southern Michigan

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Introduction

Information about the life histories of the smaller mammals is generally lacking, chiefly because of the difficulty of studying these timid and mostly nocturnal animals. The artificial nest boxes here described provide a means for the investigation of certain phases of the life histories of mice and other small mammals which previously could not be directly studied. Although nest boxes have been much used in the past for the study of birds they seem not previously to have been used for mammals.

Most of the data secured in the present study pertains to the wood-mouse (*Peromyscus leucopus noveboracensis*), but some information was secured also about the habits of the prairie deer-mouse (*Peromyscus maniculatus bairdii*). The value of the nest boxes for these studies is attested by the considerable number of individual animals kept under observation, these constituting a large proportion of the total wood-mouse populations on the areas studied.

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of Michigan. William H. Burt has given helpful advice during the course of the investigation. The facilities of the Edwin S. George Reserve were placed at my disposal by Frederick M. Gaige.

Methods

Throughout the course of the study, the field operations were conducted in such a manner that the conditions would be kept as nearly natural as possible, and so that the animals using the artificial nest boxes would not be disturbed more than necessary.

CONSTRUCTION OF THE NEST BOXES

The nest boxes (Fig. 1) varied in size from 4 x 4 x 3 inches to 9 x 7 x 5 inches. They were generally cuboidal in shape, and were constructed of one-half inch lumber. The animals used boxes made of new lumber just as readily as those made of old lumber. Likewise, boxes constructed of lumber soaked in linseed oil, to prevent warping, were used as readily as those not soaked in oil.

Each box has a removable top to facilitate examination. Experiments indicate that tops constructed of wood are better than those made of metal or other material, for the wood tends to reduce the amount of condensed moisture.

To facilitate the examination of the animals inside of the nest box, there is

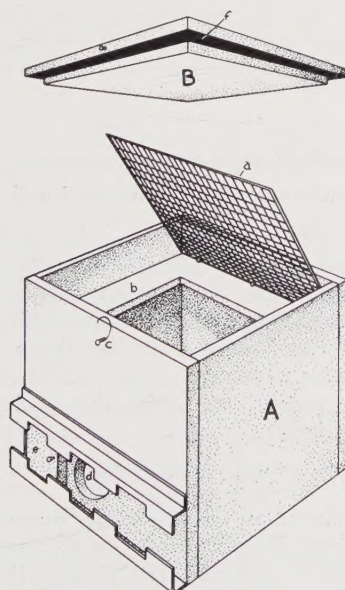


Fig. 1. Diagram of a nest box. Key: A-nest box, (a) inner door, (b) shelf for inner door, (c) hook to fasten cover, (d) opening to box, and (e) sliding door; B-cover of box, (f) sheet of tar paper.

an inside door, below the lid, made of $\frac{1}{3}$ inch mesh hardware cloth. It is therefore possible to remove the lid of the box and to determine whether any animals are present without danger of their escaping. This screen door must be fastened so that animals can not push their way above it and thereby become imprisoned above the screen. A shelf to support the inner screen door extends around the inside of the box. This should be at least an inch wide to prevent the animals from climbing the sides of the box or jumping out.

The entrance to the nest box is a one-inch round opening on one side near the bottom. This entrance can be closed from the outside of the box by means of a simple sliding door (Fig. 1). Boxes provided with two openings on opposite sides of the box, one to be used as a bolt hole by the inhabitants in the event of danger, were evidently not liked by the mice, because such boxes were rarely used by them.

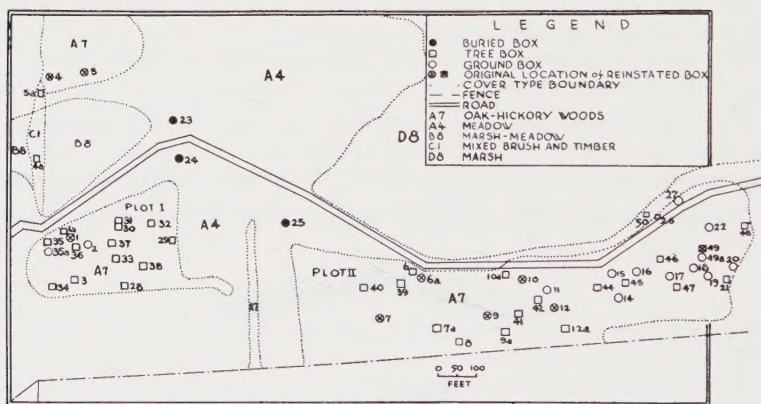


Fig. 2. Map of area studied, showing location of nest boxes.

A short wooden tunnel was attached over the opening of several of the boxes to simulate burrows. Some of the tunnels had right angle turns in them, while others were straight. Three of the boxes, designed to be buried underground, were equipped with long, sloping tunnels which would reach from the surface of the ground to the bottom of the box. Boxes equipped with tunnels were not used any more frequently than those without them. Nevertheless, the tunnels sometimes were useful in protecting the openings to the boxes from rain and especially from snow.

FIELD OPERATIONS

The study was conducted on the Edwin S. George Reserve, located near Pinckney, Michigan, about 25 miles northwest of Ann Arbor. Most of the operations were confined to two woodlots, 2 acres (Plot I) and 7.6 acres (Plot II) respectively, in area, and to the open field between them.

Fifty of the small wooden nest boxes, previously described, were put into operation between April, 1935 and May, 1937. Eleven of the boxes were later

relocated so that there was a total of 64 box locations (Fig. 2). In order that the effectiveness of the boxes under different conditions, as well as some of the factors entering into the selection of the nest by the wood-mouse, might be determined; and in order that there might be a greater possibility that the boxes would be used, the nest boxes were placed in many different situations. Some were placed on the ground within the woodlot; some were placed on the sides of trees; still others were fastened to the limbs of the trees; and three boxes were buried underground in the field adjoining the woodlots.

The nest boxes will be designated hereinafter as tree boxes or ground boxes, depending on whether they were located in a tree or on the ground. The ground boxes were placed at the base of trees, near logs or stumps, in brush piles, and under clumps of creeping juniper (*Juniperus horizontalis*). The tree boxes were placed in oak trees (*Quercus alba*, *Q. coccinea*, and *Q. palustris*), in hickory trees (*Carya laciniata* and *C. ovata*), and in a maple tree (*Acer saccharum*). These trees ranged from 4 inches to 36 inches in diameter. Most of the trees were living, but a few were dead. The tree boxes furthermore were placed at various distances above the ground, varying from 3 feet to 30 feet.

When, in two instances, two nest boxes were located in the same tree, within a few feet of each other, only one box was occupied at a time, although both boxes were used by wood-mice at different times. Likewise, only one box was used at a time in two other instances when a tree box was supplemented by a ground box at the base of the same tree. One of these ground boxes was used once by a mouse after it escaped while being examined in the tree box. The other ground box and tree box was used interchangeably by one family group of wood-mice.

One nest box was placed in a tree located about midway between the two woodlots. The tree was standing in an old, brush-filled fence row, which formed a perfect avenue of passage for the mice from one woodlot to the other. This box was used rather frequently during the summer and fall.

Food, consisting of seeds and grains of several kinds, which at first was placed in some of the boxes, proved not to be necessary to attract the mice. Rather, the presence of food had a detrimental effect by attracting red squirrels and chipmunks, which often upset the boxes and frequently chewed rather large holes in them.

Nesting material of cotton batting placed in the boxes gave best results. A box which was not supplied with cotton was used only once, so far as could be determined, in all its history (November, 1935 to January, 1938), and then merely as a feeding station. Old nesting material was replaced by fresh cotton whenever it became wet or soiled from use.

Each animal found in a box was given an individual number and marked by means of toe clips and ear punches. Toes were clipped off by means of a pair of scissors and the ears were marked with a small poultry punch. By using both of the ears and clipping only one toe, it is possible to mark several thousand animals without repeating the numbers. The mice were marked without

anesthesia, because an animal carrying the odor of ether is often attacked by its companions.

A pair of rubber-tipped thumb forceps were used to handle the mice, which were usually caught by the tail or by the nape of the neck. The mice in the nest box were transferred one by one to a small cloth sack. Record was made of each previously marked mouse and the unmarked mice were numbered and marked. Then all mice were again placed in the nest box, and its entrance door reopened.

The original plan was to examine the boxes once a week every week of the year, in order that the movements and relationships of the animals occupying the boxes might be observed for all seasons of the year. By this procedure it was expected that the examinations would not be so frequent that the mice would be frightened away from the boxes. The plan was followed as nearly as possible until late in the course of the study, when, in an effort to determine the effect of more frequent disturbance, the boxes were examined every day for a period of one week during the month.

NUMBER OF WOOD-MICE TAKEN

During the course of the study 288 wood-mice were captured, of which 154 were adult and 134 were young. All mice about 45 days of age or older have been considered to be adult. Of the adults recorded, 89 (68 percent) were males and 65 (32 percent) were females. The difference in the number of the two sexes captured is probably due mostly to the tendency of adult males to travel further than adult females (Burt, MS and Townsend, 1936). Of the 134 juvenile mice captured, 71 (53 percent) were females in comparison to 63 (47 percent) males. This difference is not statistically significant.

Of the total number of wood-mice captured in the nest boxes 174 animals (60 percent) were taken more than once. Various individuals were recaptured from 2 to 25 times, the number recaptured becoming smaller as the number of times they were retaken increased. Approximately equal numbers of adults (89) and juveniles (85) were recaptured. In proportion to the total number of mice of each age group marked, however, more juveniles were retaken than adults, probably because of less timidity. It may be assumed that one of the reasons why still more young were not recaptured is that some of them were eliminated by predators while out foraging for food. Perhaps another reason why the juvenile wood-mice were not recaptured more frequently is that the young often wander out of the area in their search for an unoccupied territory (Burt, MS).

The data given above show that males and females and both adults and juveniles make use of the nest boxes provided for them. Because 60 percent of the total number of mice using the nest boxes repeated, some of them as many as 10 to 25 times, it seems probable that the mice used the nest boxes as frequently and in the same manner as their natural nest sites.

PROPORTION OF THE POPULATION TAKEN IN NEST BOXES

During a part of the summer of 1937 W. H. Burt was trapping and marking the wood-mice on the same plots where the nest boxes were placed. Opportunity is therefore given to compare the effectiveness of traps and nest boxes for determining the population of these mice.

On the two-acre plot (Plot I) between June and August Burt had records of 14 wood-mice. Between the period June to September all these mice made use of nest boxes except two males. Of these males, however, one was taken only once in a trap and the other only twice, and there is accordingly the likelihood that these animals were killed or had left the plot before they had a chance to enter a nest box. Three additional animals, two females and a male, were captured in nest boxes, but were not taken in Dr. Burt's traps. Each of these animals was recorded only once in a nest box; they may, therefore, not have had an opportunity to enter a trap.

On the larger woodlot (Plot II, 7.6 acres) Burt had records of 17 wood-mice during the trapping period of July 9-12, 1937. Ten of these failed to enter any of the nest boxes during the period July to October. However, six of these mice had previously been marked in nest boxes, so that only four (3 males and 1 female) of the number present on the plot in July failed to enter a nest box during the summer. In addition, one subadult male marked in a nest box in July failed to enter a trap during the same period.

The 1936 season gave almost identical results, except that lower figures were obtained for the nest box captures. This was to be expected, however, because there was a smaller number of boxes in each plot.

The evidence given above shows that nearly all the animals in a given area will, at least occasionally, make use of the nest boxes provided for them.

Social Life of the Wood-mouse

Certain aspects of the life history of the wood-mouse are well known, especially the animal's habitat preferences (Wood, 1910; Dice, 1922; Townsend, 1935; and others), its home range and territorial behavior (Burt, MS), and its breeding habits (Svihla, 1932). Very little is known of the more intimate aspects of its social behavior in nature. The following data, although far from being complete in many respects, are presented to help fill the gaps in our knowledge of the habits of this animal.

NEST SITES

The wood-mouse shows, in its use of nest boxes, a very definite preference for nest sites located above the ground. Tree boxes were used by 278 mice (16 of which escaped before they could be marked or before their marks were identified) 780 times as compared to 47 mice (6 escaped) taken 79 times in ground boxes. Seventeen of these individuals used both ground boxes and tree boxes. Each of the 33 tree boxes sheltered at least one mouse during the course of the study; but mice were captured in only 14 of the 23 ground boxes. Eight

other ground boxes, however, harbored mice at one time or another, as indicated by the presence of feces, food, or nests. One ground box was never used, so far as could be determined. The number of different mice which at various times occupied each of the 33 tree boxes during the nine months from May, 1937 to January, 1938, averaged more than five and ranged from 2 to 24 individuals. The largest number of mice to occupy at various times a single ground box was 9 individuals, but these were taken over a period of twenty-three months, from March, 1936 to January, 1938. The average number of different individuals (unmarked young excluded) using the ground boxes from time to time during the twenty-three month period of their service was about 1.8 mice per box.

Another indication of the preference for tree nest sites by the wood-mouse is the number of litters found in tree boxes as compared with the number found in ground boxes. Only three litters were taken in ground boxes while 34 were taken in tree boxes.

The evidence from the use of the nest boxes further seems to indicate that the wood-mouse prefers nest sites along the edge of the woodlot or in close proximity to the edge. Nineteen of the tree boxes were placed either on peripheral trees or within 25 feet of the edge of the woodlot, while 15 boxes were situated well within the woods. The average number of mice taken per peripheral tree box was 8.3 mice, taken on 8.5 occasions, while for the centrally located boxes, the average was 4.6 mice per box on 6.8 occasions. Because nearly twice as many mice were captured in boxes near the edge of the woods as were taken in the center of the woodlot, it seems reasonable to conclude that the wood-mouse shows a preference for nest sites located near the edge of the woods. The number of occasions on which the different boxes were used by mice leads to the same conclusion. The majority of the litters taken in boxes were first found in peripheral tree boxes, further indicating that the wood-mouse prefers nest sites near the edge of the woods.

There is no apparent correlation between the amount of use of tree nest boxes by mice and the size of tree, kind of tree, or height above the ground. Because so few mice were taken in ground boxes, it is impossible to correlate the amount of use by mice with the location of the boxes in relation to stumps, trees, brush, or creeping-juniper bushes. Neither is there any evidence that nest boxes of a certain size were used; the mice used large boxes as readily as small boxes, and also nest boxes of intermediate size.

The site of one natural nest was found in the branch of an oak tree (*Quercus palustris*), when a nest box was being placed in the same tree. The opening to this nest was a longitudinal crack on the upper surface of a branch which had rotted out, leaving an opening about one inch in diameter. The nest was not disturbed; therefore, it is not known how deeply into the heart of the branch this opening led, but from appearances the hollow was quite extensive. The opening to the nest was 7 feet above the ground in a tree 9 inches in diameter. This nest was used by mice from September 22, 1936 until February 5, 1937. So far as could be determined, the nest was not used after that time. This nest was located on the edge of the woods.

The amount of use of tree nest boxes in comparison to the amount of use of ground nest boxes seems, therefore, to show that the wood-mouse usually makes its home above the ground. In addition, the wood-mouse shows a preference for nest sites located near the edge of the woods. This rodent seemingly does not have any preference for nest boxes located in trees of different sizes or kinds; neither is there any apparent preference for nest boxes located a certain height above the ground. The one natural nest site found was in a tree near the edge of the woods.

SEASONAL VARIATION IN THE USE OF NEST BOXES

Their use of nest boxes indicates that wood-mice seldom live on the ground during the summer; but during the winter, from November to March, a few mice nest on the ground. Of the forty-seven mice taken during two years in ground boxes, thirty-four were taken in the winter, the other thirteen being taken during the summer and fall months.

One condition which seemingly influences the ground-nesting of the wood-mouse in winter is the amount of snow. Apparently the greater the depth of the snow, the more readily will the mice nest on the ground. Twenty-two of the mice taken in ground boxes were taken during the winter of 1935-36, when the snow was piled up between two and three feet deep in some places in the woodlot. In the winter of 1936-37, with an almost complete absence of snow, only four mice were found in ground boxes. Eight mice were captured in ground boxes the winter of 1937-38, when the snow reached a depth of 6-8 inches. This was in spite of the short period of study (November to January).

The sparse indication given by the presence of feces, food, and nests in ground boxes, bears out the suggestion that very few mice live on the ground during the summer, but that they nest on the ground more frequently in the winter.

There is little evidence to support the suggestion (Wood, 1910) that there is a seasonal selection of nest sites near the edge of the woodlot. Although the one box located in the fence row was used only during the summer and fall months, and one box located on the edge of the woods was not used after November, another similarly located was used throughout one winter season by wood-mice. Johnson (1926:263) also has reported this species as frequently near the edge as in the middle of the woods at all seasons.

The wood-mouse then demonstrates an apparent preference for tree nest sites at all seasons of the year, but there is some tendency for individual mice to live on the ground in the winter when there is snow on the ground. There is seemingly little if any seasonal difference in preference for nest sites located on the edge or in the center of the woods.

CONSTRUCTION OF NESTS

Usually the mice were satisfied with the cotton batting provided as nesting material. Other articles, however, such as grass, leaves, hair, feathers, rags, and milkweed floss, have been added by the mice at various times to the cotton and

incorporated in the nest. On one occasion, an adult male mouse removed all the cotton from a box and then brought in milkweed floss and constructed his nest. When the nest was again examined, two weeks later, this male was absent, but three subadult males and one subadult female had taken over the nest and added more milkweed floss. Still later another set of mice, an adult pair and four young, occupied this nest but did not bring in any additional material, as far as could be determined.

An adult pair of mice occupied one box which was not supplied with cotton nesting material. These animals constructed a nest of dry leaves and grass. The leaves were cut into very small pieces.

The mice which used the natural tree nest site apparently constructed their nest of cotton batting, getting their supply from the nest box located within a few inches of the opening to the natural nest. When the mice were first discovered in September, they seemed to have a large enough supply of nesting material or were deriving it from some other source, for no cotton was taken from the box until October. During the latter part of October and through November, cotton batting placed in the box was removed almost immediately and because the opening to the natural nest site was eventually stuffed full, it was assumed that the mice in the natural nest were responsible for the disappearance of the cotton. By the end of November, the mice apparently had taken all they could use, as no more cotton disappeared from the box.

That cotton batting is used when available by the mice in their natural nests is evident, because cotton which was supplied to the nest boxes frequently disappeared and had to be replaced.

All the nests were constructed in essentially the same manner. The cotton batting was first shredded and then built into a globular form, hollow in the center, and with but a single opening. When the nest was in use the entrance was closed, and it also was frequently closed when the nest was not in use, as if the owner intended to return. Ordinarily, the opening to the nest faced the entrance to the box. Occasionally, however, it faced one side or the other, but in no case was it found to open toward the rear of the box. The nests were almost always completely roofed over, even in summer. Occasionally, the cotton had been brought up against the screen of the inner door leaving an opening of about one inch in diameter. In the winter months there was a tendency to build up the floor of the nest so that it was elevated above the top of the opening of the box. The nests made of leaves and milkweed floss were similarly constructed.

SANITATION

The fecal pellets of the wood-mouse are dropped promiscuously inside the nest boxes, and even inside the globular nest balls. The mice also urinate inside the nest boxes, but usually in the corners of the boxes, outside the nest ball. Even though the mice leave the cotton nest to urinate, the moisture remains inside the nest box and is soon absorbed by the cotton nesting material. The urine and fecal pellets together make some of the nests very foul and damp, therefore, in the winter portions of the nest are often frozen solid.

No natural nests have been examined but there is no reason to suppose that the wood-mouse is any more sanitary about its natural nests than about the nest boxes. Dice (1925:7) found some excreta in a *P. m. gracilis* nest.

Food was frequently eaten inside the nest box, and the remains, the shells of hickory nuts and acorns, were dropped on the floor. Eventually, the shells were packed into the nest material, thus rendering the bottom of the nest uneven and probably uncomfortable. The accumulation of nut and acorn shells hastened the soiling of the nest considerably.

Ectoparasites were not very evident, either on the mice or in their nests. A few lice (species not identified) were found on some mice; but only one nest seemed to be infested with these parasites. This nest was cleaned out, fresh cotton was put in it, and the lice were thus eliminated.

In spite of their unsanitary habits about the nest, all the mice captured were clean and the ventral surfaces of their bodies were immaculately white. It has been noted in the laboratory that captive mice spend much time on their personal toilet; apparently wild mice do likewise.

CO-RESIDENTS

Invertebrate animals other than ectoparasites were sometimes found in the nest boxes together with wood-mice. The nymphs of the wood-roach (*Parcoblatta pensylvanica*) occurred in nearly all the tree boxes during the summer, sometimes in large numbers. The presence of the wood-roach seemingly did not interfere with the occupancy of the boxes by the wood-mice; nor did the mice seem to interfere with the roaches. Ordinarily the roaches were found above the inner door of the box, but regardless of whether the box was occupied by mice, the roaches would run down inside the box when the cover was removed. It is not known definitely whether the mice ever killed any of the roaches, but to all appearances these two kinds of animals lived in harmony.

Hornets (*Vespa maculifrons*) lived above the inner door of two different boxes at the same time the boxes were occupied by mice. The hornets had to gain entrance to their living quarters by the same opening which the mice used. Two wood-mice lived in the same box with hornets for a period of over a month.

Wood-mice occupied two nest boxes which were being used at the same times by carpenterants (*Camponotus herculeanus*). The ants were eliminated from both boxes in which this combination was found, by leaving the covers off as soon as the boxes were not occupied by mice. In both instances the mice were in the boxes with the ants only once.

Other animals were found in nest boxes on various occasions, but mice were not taken at the same time. In each instance it is doubtful whether any mice entered the boxes during the periods these other animals were present. A bumble bee (*Bombus* sp.) took over one box, a dead salamander (*Ambystoma maculatum*) was found in another, and on three occasions a tree toad (*Hyla versicolor*) was found in another box.

FOOD AND FOOD STORAGE

Acorns, hickory nuts, and corn (maize) were the only articles of food found in boxes used by the wood-mouse. Other types of food were probably brought into the nest and consumed, but either all such food was eaten, or the left-over particles were too small to be obvious. Although insects, such as the wood-roach and hornets, were sometimes found living in the same quarters as the wood-mice, there is no evidence to show that the mice killed and ate any of these insects.

When eating an acorn, the wood-mouse usually removes the cap, cuts the acorn in two around the middle on the mid-line, and then removes the meat from each half shell. Occasionally, the acorns are opened by shredding the shell down on all sides from the apex. Because the shells of the acorns were almost invariably destroyed, it was impossible to identify all the kinds of acorns consumed, but most of the kinds found on the George Reserve apparently were eaten. The red acorn, one of the most bitter, is apparently used for food as readily as any of the others.

Hickory nuts are always opened in the following manner: two holes are gnawed in the sides of the nut, opposite to each other. These openings usually occupy a little more than a quarter of the surface of each side. The openings are always made on the sides, crossing the longitudinal split in the nut; thus, when the openings are finished, the edge of the two halves of the kernel are exposed on both sides. Through these relatively small openings, the mice are able to obtain every bit of the food in each side of the nut. The mice eat both thin-shelled and hard-shelled nuts, both bitter and sweet nuts, all seemingly with the same readiness.

Traces of corn were occasionally found in some of the boxes. The wood-mouse consumes the entire kernel of corn, contrary to the habits of some other rodents, particularly squirrels, which eat only the germ and discard the remainder. Possibly the mice in the boxes derived their supply of corn from squirrel middens, carrying off discarded parts of kernels as well as whole kernels which had been dropped. The squirrels obtained the corn from cultivated fields adjacent to the Reserve.

The wood-mouse did not store any food in the nest boxes; but, from the condition of the empty shells, it was evident that the nuts and acorns were taken from some cache. The empty shells of both acorns and hickory nuts were found at all seasons of the year, but, at no season did the nuts show evidence of having weathered, nor were green nuts found during the summer. Therefore, both acorns and hickory nuts must have been cached somewhere. Many authors tell of finding the storehouses of the wood-mouse, but no one has mentioned finding the nest and storehouse in the same place.

PERIODS OF RESIDENCE

A wood-mouse seldom resides long in one nest box, but rather, it usually, though not always, leaves the box after a short period of residence, to reappear in the same box or in another box after a period of two or three weeks, or occasionally, of several months.

Of the 174 mice captured more than once in nest boxes only 16 lived in the same box for more than four consecutive weeks. Of these, four males and four females were each taken in the same box for four consecutive weeks; four males and one female were each taken over a period of five weeks; one male and one female were each taken over a period of six weeks; and one female was taken eight consecutive weeks in the same box. Each of two pairs from among the above mentioned mice remained in the same nest box for a period of five continuous weeks.

When the boxes were examined every day for a week, only three animals, an adult male, and an adult female and her one female offspring, were found to remain in the same box the whole week. Some of the mice remained in the box for two or three days and then disappeared, some returned after a day or two, but the majority of the mice were taken only once during the week of continuous examination.

More than half (9) of the mice which were taken in the same box more than four consecutive times were taken in the winter. Of the other 7 animals, three were repeatedly taken in the same box in the fall months and four were taken in the summer months. The three mice captured every day for a period of a week were taken in November and January.

Whether the wood-mouse normally changes its place of residence under natural conditions as frequently as indicated by these records, or whether these animals moved from the nest boxes because of being disturbed, is impossible to determine. However, because few mice lived in one location for more than a month, it seems logical to conclude that the wood-mouse changes its place of residence rather frequently.

LOCAL MOVEMENTS

Most of the movement involved when a wood-mouse changes its place of residence seems to be local, that is, within the normal home range of the individual. Of the 174 mice which repeated one or more times, 112 were taken in the same box each time, and 62 were taken in two or more boxes. All 62 of the mice using more than one nest box were retaken at one time or another within 200 feet of the original place of capture. Of these, 25 were adult males, 10 were adult females, 11 were immature males, and 16 were immature females.

Nest boxes which were more than 200 feet apart were used by five adult males, two adult females, three immature males, and one immature female. It will be noted that more adult males than females were taken in two or more nest boxes, both among those which showed only local movements and those which wandered more widely. This would be expected due to the greater wandering tendency of the males.

Those animals which were always taken in the same box demonstrated some local movement also, because most of these mice were not recaptured every consecutive week. Although it is impossible to tell how far the mice moved between visits to any one particular box, there must have been a certain amount of movement involved between nest boxes and natural nests.

The record of adult male No. 311 is a good example of the wanderings of these mice. This mouse was taken a total of 25 times, always in the same general region. He was first taken in box No. 3 (Fig. 3) on June 17, 1936, as a subadult. He remained in box 3 for 3 weeks, then on July 23 he was taken in box 28, about 90 feet away. August 11 and 18, and September 4 he was again taken in box No. 3. This animal did not make use of any box again until May 11, 1937 when he was taken in box 3; May 25 he was in box 34, approximately 90 feet away from box 3; June 8 he was in box 33, 160 feet from box 34 and approximately 70 feet beyond box 3. June 15 and 25 he was found in box 36, 95 feet from box 33. July 19 he was taken in box 37, 30 feet above the ground and 90 feet from box 36. August 3 he was again in box 36. August 10 he went back to box 37 on August 10. August 16 he was in box 3; August 17 in box 36; and on the 18th he was back in box 3. Between each of the last four dates this mouse moved his residence about 80 feet. He was not taken after August 18, 1937. Although this male used different nest boxes in 1936 than in 1937 he remained in the same local area.

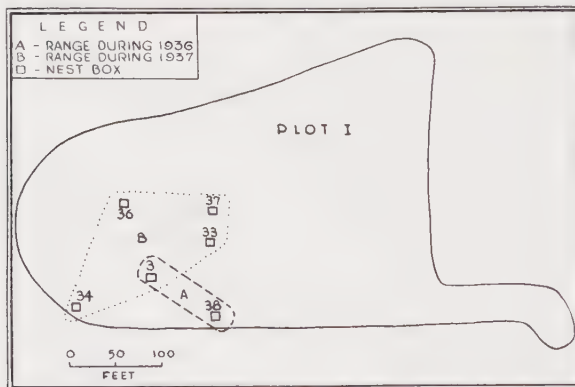


Fig. 3. Sketch map of the range of the movements of male No. 311 during two summer seasons, showing location of boxes occupied.

Nursing females make a practice of changing their place of residence rather frequently, taking their young with them. Females and their litters, of which the young mice ranged in age from one to 40 days old, were taken 34 times. Most of these young mice were between 15 and 40 days old. Because so many young between these ages were moved from nest site to nest site, it seems plausible to conclude that it is a regular procedure for females to move their young, perhaps several times during the nursing period. One female brought three litters into a nest box during one breeding season, the young of each litter being on each occasion from 18 to 25 days of age.

It is evident from the preceding discussion that a wood-mouse frequently changes its place of residence, but that most of the movements involved in the exchange of nesting sites is local. Adult males appear to move about more than adult females. Adult females with litters frequently change their place of residence.

DISPERSAL

The data are too few and inconclusive to determine whether or not the mice move their home sites more frequently or travel farther in summer than in winter.

Only 11 wood-mice were taken more than 200 feet from their place of first capture. Because of the importance of these for indicating the dispersal rate of the species the record of each of these animals will be given here.

One of the adult males moved, during a period of two weeks in summer, from a nest box in the woodlot into another box in the fence row, a distance of approximately 300 feet, and back to a nest box in the woodlot. Another adult male moved in November from the box in the fence row to a box in the woodlot, a distance of slightly more than 200 feet. Two other adult males travelled in the late fall, respectively, 280 feet in one week and 220 feet during a period of two weeks. One other male, trapped and marked in one woodlot by Burt during the fall, was taken the following July in a nest box in the other woodlot, a movement of over 1,500 feet. Except for this one animal, none of these mice moved very far.

One adult female, moved a distance of approximately 500 feet between July and November, from the nest box in the fence row to a nest box in the woodlot. However, her travel was accomplished sooner than the box records would indicate, for this mouse was trapped by Burt in the woodlot one week after she was taken in the nest box in the fence row. She was then only about half way between that box and the one in which she was captured in November. The other female travelled a distance of approximately 300 feet in one week in a similar change of nest boxes.

One juvenile female, which was taken on September 1 with her mother and siblings, was found November 3 in another box in the same woodlot, approximately 550 feet away. Two juvenile males from the same litter moved from one woodlot to another, a distance, for one mouse, of over 900 feet, and for the other, of about 750 feet. Both of these mice moved from the one woodlot to the other between November 3 and January 27. Another juvenile male moved, between November and April, a distance of slightly more than 200 feet, within the same woodlot.

Very few wood-mice, so far as these records show, move the location of their homes over a greater area than might be expected to be included in a normal home range. The longest movement, by an adult male, was over 1500 feet. One adult female was taken in nest boxes about 500 feet apart. A juvenile female moved about 550 feet. Two juvenile males moved respectively 900 and 750 feet. Six other wood-mice moved distances between 200 and 300 feet from their places of first capture. All the other mice which were captured in more than one nest box, were, as shown in a previous section, taken within a radius of 200 feet from their place of first record.

SEX RATIO

Eighty-nine adult males were taken in comparison to 65 adult females, while 63 juvenile males were captured in comparison to 71 juvenile females.

The amount of deviation from a possible 50-50 ratio is not statistically significant for either age class.

The ratio of males to females in the litters probably gives a more accurate statement of the sex ratio at birth. In 26 litters, with an average of 3.6 mice per litter, there were 48 males and 46 females. Groups of three or more mice, obviously of the same age but less than 45 days of age and those which were still being nursed by an accompanying female, were considered to be litters.

RELATIONSHIP BETWEEN ADULTS AND YOUNG

Few litters were born in the nest boxes, but litters of various ages were from time to time moved into the boxes; therefore it has been possible to record some of the relationships between the adults and young.

It has already been mentioned that groups of three or more mice, obviously of the same age but less than 45 days of age when first captured, were assumed to be litters. The age of these young mice was determined partly by the criteria given by Svihla (1932) and partly by criteria which are the results of my several years experience in handling mice of known age in the laboratory. Svihla states (p. 23) that young of the species *leucopus* when first born are naked, flesh colored, blind, and the pinna of the ear is folded down flat against the lower portion of the ear; on the second day after birth, the dorsal region of the body becomes darkly pigmented; and by the third day the pinna of the ear is unfolded. My observations show that in this species the hair becomes discernible to the naked eye on about the fourth day, and on the sixth or seventh day the young are completely haired. By the tenth or eleventh day, the young are able to walk by themselves, although they are still weak and crawl much of the time. At between 13 and 14 days of age the young of *noveboracensis* open their eyes (Svihla, p. 29).

After the eyes are opened it becomes extremely difficult to determine the exact age of the young wood-mice. However, until they reach the age of about 40 to 45 days, their age may roughly be estimated from their size. Young of this species are slightly less than half grown at the time the eyes are opened (14 days), fully half grown at about 18 to 20 days of age, and about two-thirds grown between 25 and 30 days of age. When they reach the age of 40-45 days it becomes almost impossible to separate the young from adults on the basis of size, but observations in the laboratory indicate that the young retain their gray juvenile pelage until about 40 to 45 days of age; at 45 days of age the buff of the adult pelage becomes apparent in the dorsal stripe; and by 60-75 days of age the adult pelage is almost completely attained.

A total of 37 litters were observed in the nest boxes, of which only five could possibly have been born there. Two of these litters were undoubtedly born in the nest boxes, because they were not more than one day old when found, and three other litters, ranging in age from two or three days old to six or seven days of age when found, probably also were born in the nest boxes. The other 32 litters were not born in a nest box, because they were over a week old when first found and they had not been present at the previous weekly examination. Seven litters were between 9 and 18 days of age, 16 litters were

TABLE 1.—Association of sexes and age classes of wood-mice in nest boxes.
Number of times each combination was taken each month.

	Breeding season						Non-breeding season						Total
	March	April	May	June	July	August	September	October	November	December	January	February	
Number of seasons	2	2	2	2	2	2	2	3	3	3	3	1	
Mice captured	4	17	41	43	38	24	70	65	107	76	55	14	
Times taken	5	26	57	62	45	34	98	87	172	106	82	18	792
1 animal													
Adult male	3	9	5	10	9	14	25	16	15	7	9	2	124
Juvenile male	--	--	--	1	3	1	3	2	--	--	--	--	10
Adult female	2	11	1	3	2	2	3	4	9	8	16	--	61
Juvenile female	--	--	--	3	4	1	2	1	--	--	--	--	11
Undetermined	--	--	--	--	2	2	2	--	1	1	--	--	8
Total													214
2 animals													
Adult pair	--	--	4	1	1	6	1	2	19	17	7	3	61
Juvenile pair	--	--	1	1	--	--	3	2	1	1	--	--	9
Pair (female juvenile)....	--	--	1	3	--	--	2	9	--	--	--	--	15
Males	--	--	--	--	--	--	--	21,2	3	1	3	1	10
Females	--	1	--	--	--	--	--	1 ¹	--	1	--	--	3
Total													98
3 animals													
Males	--	--	--	--	--	--	--	1	--	--	--	--	1
2 males + 1 female.....	--	--	--	--	--	--	--	--	1	1	2	--	4
2 females + 1 male.....	--	--	--	--	--	--	--	--	2	3	3	1	9
Total													14
4 animals													
2 males + 2 females.....	--	--	--	--	--	--	--	--	--	2	--	--	2
3 males + 1 female.....	--	--	--	--	--	--	--	--	1	1	--	--	2
3 females + 1 male.....	--	--	--	--	--	--	--	--	1	1	1	--	3
Total													7
5 animals													
3 females + 2 males.....	--	--	--	--	--	--	--	--	--	1	--	--	1
4 females + 1 male.....	--	--	--	--	--	--	--	--	--	1	--	--	1
Total													2
6 animals													
3 females + 2 males +													
1 undetermined	--	--	--	--	--	--	--	--	--	--	1	1	2
3 females + 1 male +													
2 undetermined	--	--	--	--	--	--	--	--	--	1	--	--	1
Total													3
Litter associations													
Female + litter	--	--	4	5	2	2	6	7	16	1	--	--	43
Male + litter	--	--	1	--	--	--	2	--	1	1	--	--	5
Pair + litter	--	--	2	--	--	--	2	1	5	1	--	--	11
2 males + 1 female +													
litter	--	--	--	2	--	--	--	--	--	--	--	--	2
Female + litter +													
male of previous litter ..	--	--	--	1	--	--	--	--	--	--	--	--	1
Female + litter +													
previous litter	--	--	--	--	--	--	--	--	2	--	--	--	2
Litters not associated													
with adults	--	--	1	--	1	--	1	1	4	3	--	--	11

¹ Juveniles.² 1 adult 1 juvenile.

between 18 and 25 days old, and 9 litters were between 25 and 40 days old when first found. The majority of these older litters were between 25 and 30 days of age when they were discovered in the boxes.

Twenty-eight adult females, assumed to be the mothers, were associated with 32 litters living in the boxes. One female was the mother of three different litters and three other females were the mothers of two litters each.

It is shown in Table 1 that litters were taken in the nest boxes a total of 75 times. They were, however, taken independently of their assumed mothers on only 16 occasions, on 11 of which they were not accompanied by adults, and on 5 of which they were associated with single adult males. All of the litters unaccompanied by an adult female were 20 days old or older and all but one were 25 days old or older. Most of these litters were between 25 and 30 days of age. Only one 20-day-old litter was taken alone. It was only during November and December that litters older than 40 days of age were accompanied by adult females. Because each litter was accompanied by an adult female until it was at least 20 days old and more usually 25 to 30 days old, and because none was accompanied by an adult female after it was 40 days old, except during the non-breeding season, it may be concluded that the young of this species are weaned between the age of 20 and 40 days and usually between the age of 25 and 30 days. The weaning age as here determined agrees with the observations of Svihla (1932:30) on laboratory reared wood-mice. Svihla found that, depending on several factors, the young of *noveboracensis* were weaned between the age of 22 and 37 days.

Until the young are near weaning age, it seems to be unusual for adults, other than the mother, to be found in the same nest with the young. Only one instance was recorded in the present study in which young less than 18 days of age were found with any adults other than their presumed mother. In this one instance, a female was taken with a 9-day-old litter and with one young male, about 37 days of age at the time, from her previous litter. This seems to suggest that until the young are about ready to be weaned, the mother, ordinarily, does not tolerate other mice in the nest with her young. Laboratory observations show that females with litters, though not always, force the male and the previous litter out of the nest when a second litter arrives.

On the other hand, after the young reach an age of about 18 days, or more frequently of 25 days or more, adult males are occasionally found in the same nest with the female and young. Of the 11 instances in which males were found associating with females and their litters, the young were 25 days old or older, except in three instances, one in November when a male was taken with a female and an 18-day-old litter, and two in June, when two subadult males, both obviously of the same age and possibly of a previous litter, were taken on two successive weeks with a female and an 18-day-old litter.

Single adult males were taken with litters on five occasions (Table 1). In all five instances, the males had previously been living with the litters and with the mother. Apparently the mother left the nest box, leaving the young and the adult male together. The male does not always remain with the litter and

weaned litters were taken alone on 9 occasions. After weaning, the litter usually breaks up and then, adult males frequently become associated with some of the young females. Adult males thus became associated with single young females on 15 occasions (Table 1). From the foregoing, it would seem that, although males frequently associate with litters and their mothers just about weaning time, males do not ordinarily continue to associate with the weaned litter, but they may attach themselves to single young females from these litters, after the litter breaks up.

Young males, after the family group has broken up, seldom associate with adults of either sex. The two instances of an association between adult females and young males have already been mentioned. In only two instances were young males found with adult males. Both occurred in October and in one instance a young male was found with a single adult male. In the other instance, one juvenile male was taken with two adult males.

It has been intimated during the discussion that the relationship between adults and young males may be slightly different in winter than during the summer and although it is not indicated in Table 1, litters do remain with their mother a much longer period of time in winter than in summer. For instance, one female and at least part of her litter remained together or in the same vicinity all winter long, until the beginning of the following breeding season. This female was taken with a litter 25-30 days of age on November 5, 1936. On November 12, she was taken again with five of these young (3 males and 2 females). On November 19, the female was taken with four of her brood (2 males and 2 females). The one young male was not taken again and it is possible that he was killed by a predator. All the mice disappeared then until January 14, 1937, when the old female reappeared with three of her brood and an adult male. On January 28, the old female was alone. On February 5, one of the young males and the adult male were taken together. On February 19, the two young females and two adult males were taken together, and also another wood-mouse which escaped. From that time on only single animals were taken in the nest box, until April 13, when the old female reappeared in a nest box with one of her daughters and another male. Neither the young mice nor the old female were taken after this date.

Other late fall litters have remained together or with the female throughout a portion of the winter. A female was living with one young female (18 days old) on November 3, 1937, and the two remained together through January 5, 1938. Another female was found with a litter of five young about 17 days old on October 6, 1937. All the mice disappeared until November 3, when the female appeared with a new litter of five young about 18 days old plus 3 of her previous litter. On November 10, she was taken with the three young of the former litter and four young of the latter litter. On November 15, she was with three young (2:1). The female then dropped out of the picture, but portions of the litters were taken on December 4 and on December 8.

During the summer, the longest time any part of a litter remained with the mother was about 37 days (one instance); on the contrary, in late fall and

winter litters occasionally remained with their mothers until they were between 45 to 60 days of age (3 litters).

Although the number of instances in which adult males were found with litters or with females and their litters, was not any greater in winter than in summer, the frequency of these associations is seemingly greater in winter. It is shown in Table 1, that 8 instances were found in the two month period from November through December, while 8 instances were also found in summer but the latter instances were found over a period of 6 months, from May through October. The two instances in which adult males were found with young males were in late October. This sort of combination did not occur earlier in the season.

In summary then, the use of nest boxes seems to indicate that of the 37 litters taken in nest boxes, very few were born in the boxes, but several litters were moved into the boxes shortly after birth. Further, litters are found with their mother until they are weaned, or until about 25 to 30 days of age. Other adults are seldom found with mice younger than 18 days of age, but after reaching this age and before weaning, adult males frequently become associated with young animals and their mother. After weaning, very few adults associate with litter groups, but as the litter breaks up, adult males occasionally become associated with single young females, but very rarely with young males. In winter the association between the young and the mother persists longer than in summer. Adult males, either related or unrelated become associated with litters more frequently and for longer periods in winter than in summer.

ASSOCIATION OF MALES WITH FEMALES

There is a different aspect to the behavior of the mice toward each other in the non-breeding season, extending from November through February, from that of the breeding season of March through October (Table 1). The table is composed of data secured from two years study, except for October, November, and December, which are represented by data for three years, and for February which is represented by only one year.

March marks the beginning of the breeding season, which extends through October. The length of the breeding season as indicated here is supported by the trapping records of Burt (MS). Burt found that some females of this species gave birth to young on or about the first of April. With a gestation period of about 23 days (Svihla, 1932) Burt's findings indicate that breeding begins early in March. Information from the use of nest boxes shows that some litters were born as late as about the middle of October, and several were born about the first of October. The non-breeding season, therefore extends from October to March. During the non-breeding season the vaginas of females are usually closed and the testes of males are usually abdominal in position.

During the breeding season, the wood-mice are usually found living singly, although occasionally certain animals associate with each other for a short period, especially as pairs. Of 43 animals taken a total of 62 times in June, the mice were taken singly on 17 occasions, as pairs on 7 occasions, and as

females with litters on five occasions (Table 1). This does not present a clear picture of the exact conditions, because 19 of these 43 animals were taken 24 times as members of litters. When these 19 animals and their mothers are excluded, it is then evident that the other mice usually lived alone. The remaining 19 mice were taken singly on 17 occasions and were found associating with each other on only 8 occasions. Three of the latter instances were associations between adult males and juvenile females, and one was an association of a male of a previous litter with a female and her new litter.

That the mice usually live alone during the breeding season is still more evident when the records of individual animals are presented in detail. One adult male was taken 10 times between May 18, 1937 and October 16, 1937. He was alone on 9 occasions and the other time he was with a female and her litter. An adult female was found twice alone and once with a single male. Another female was taken once with a male and her litter and twice with a litter. One male was taken 9 times and 7 of these times he was alone. On each of the other two occasions he was with a single female.

Although two or more animals occasionally live together during the breeding season, such associations are usually not very persistent. In one instance an adult male was taken with a female and her litter; the following week the male was found with the litter; the next week he was with two of the juvenile females from the litter; and the fourth week he was with only one of the juvenile females. After the fourth week, this male was not found with any of his previous associates. In another instance, an adult male was taken with two juvenile females and one juvenile male for three consecutive weeks. One juvenile pair from the same litter remained together for two weeks after the litter broke up. Very few associations composed of more than one animal of the same sex are formed during the breeding season, except family groups. There were only six instances in which such associations were found, and these were all found at the extreme limits of the breeding season. In April, two adult females were found together once, and on one other occasion in April two adult females and one adult male were found together. In October, two juvenile males, and two juvenile females, respectively, were taken together on one occasion each. On two other occasions, three males and two males, respectively were taken together. In each of the latter two instances one of the males was a juvenile.

During the non-breeding season, the relationship between males and females has an entirely different aspect from that of the summer season. During the winter, males and females are still found singly, but they are taken together more frequently than during the breeding season. Furthermore, combinations in which the sexes are unequally divided are occasionally found in winter.

It has already been mentioned that litters or parts of litters frequently remain together throughout the non-breeding season. If the litters break up, the various members usually become associated with other individuals, either males or females.

Most of the associations formed in the winter are between a single male

and female; however, in winter wood-mice often form associations with an unequal sex distribution. Twenty-nine of these associations are listed in Table 1 for the winter season, and besides these, there were thirteen other instances in which one animal escaped before its sex could be determined.

Pairs of mice, male and female, were found together on 48 occasions during the winter season. Two males were together on nine occasions and two females were found together on one occasion. Mixed groups of three were found on thirteen occasions. Mixed groups of four mice were found on seven occasions and in two of these instances, two males and two females were taken together. In two instances during the present study five animals were taken together, and in both instances there were more females than males in the group. On two occasions 6 animals were taken together, but each time one or two animals escaped, and the numbers of each sex in the aggregation was not determined.

From the evidence given above, it appears that during the breeding season wood-mice usually live singly. Occasionally, for a brief period, a pair may live together. During the non-breeding season the males and females frequently live alone. They, however, sometimes live together, ordinarily as pairs, but occasionally in aggregations in which the sex distribution may be unequal.

INBREEDING

The possibility of close inbreeding at times in the *noveboracensis* population on the George Reserve, is indicated by the data secured from the use of the nest boxes. For instance, an adult female and an adult male were taken together in February, 1937, and although these mice were not again taken together until May 11, it is possible that the male was the father of the two young females found with the pair at that time. The male was found with one of the young females on May 18, on May 25, and again on May 31. On the latter date the young female seemed to be in early pregnancy. Unfortunately this female was not taken again, and therefore it was not possible to check further on her condition. Although this female was only about 50 days old on May 31, she may have been impregnated by her presumed father. Clark (1938) found that females of this species have their first estrum, on the average, at about 46 days of age, and he records one instance in which a female conceived at the age of 39 days.

The above cited instance is the only one found by me in which there is a suggestion that a pregnancy resulted from the association of two wood-mice of close relationship. However, there are other instances in which presumed fathers associated with their presumed daughters a long enough period for mating to have occurred. In one instance a female and part of her last litter of the previous breeding season remained together all winter, and this association possibly may have resulted in a pregnancy of the mother by her son. However, in this particular instance, the female was not taken again after the last time she was found with her offspring in the spring and therefore, it was impossible to tell whether or not she was impregnated.

It is possible that some of the males and females of the same litter which

remain associated with each other for a considerable time also mate. A male and a female of the same litter, first taken on September 1, remained together in the same box until September 22. They both disappeared after the latter date, but at that time they were about 42 days of age, and unless the combination broke up when they left the nest box, it is possible that they produced young. The fact that litters in some instances, remain together all winter possibly could result in the first litter of the next season being the result of a union between brother and sister.

The above evidence seems to indicate that there may be a slight amount of close inbreeding in the wood-mouse populations. Matings may take place between father and daughter, mother and son, or brother and sister, for these combinations have been found in the nest boxes up until times when breeding may have occurred. However, no case of such close inbreeding has been positively proved.

Records of Other Species

Other small mammals, besides the wood-mouse have made use of the nest boxes from time to time. On several occasions, chipmunks (*Tamias striatus lysteri*) have run out of the ground boxes when they were opened, and one chipmunk was taken in a tree box. The one animal taken in the tree box was marked, but was not retaken. Other chipmunks escaped before they could be marked, therefore it can not be said whether the same individuals made repeated use of the boxes or not.

Meadow voles (*Microtus pennsylvanicus*) used one of the underground boxes on four occasions during the winter of 1936. A male *Microtus* was taken alone on December 22, 1936. The following week he was in the same box. Thereafter two new *Microtus* were taken, each one alone. Neither of the latter two mice were recaptured. Unfortunately, about the middle of February, run-off from a heavy rain filled the box with water which then froze rendering the box useless until April. No other *Microtus* were taken in nest boxes throughout the study. Wood-mice were never found in the nest boxes in association with either chipmunks or meadowvoles.

A total of 16 prairie deer-mice (*Peromyscus maniculatus bairdii*) were captured in nest boxes. All of these were captured either in the fall of 1937 or the winter of 1937-38. Because so few *bairdii* were captured, very little can be said concerning the home life of this species; however, the evidence from the nest boxes seems to indicate that *bairdii* does not differ very greatly in its life habits from *noveboracensis*.

The 16 prairie deer-mice were taken a total of 136 times, 14 animals each being recaptured from 2 to 13 times. One subadult pair of mice were taken together once in a box, another male and female were taken together twice, and the other 12 mice were each taken from 6 to 13 times.

With the exception of two *bairdii* of doubtful identification, which are not included in the total number recorded here, all the *bairdii* were taken in one

or the other of the three buried ground boxes, located in an open field between two woodlots (Fig. 2). The two doubtful animals mentioned above were taken in a ground box located in the edge of the woods during the winter of 1935-36. Unfortunately these two animals escaped at the time of first capture and were not taken again, therefore they were not positively identified. Because the winter of 1935-36 was a relatively severe winter, it is possible that these two deer-mice moved into the edge of the woods for the added protection the trees would afford them.

Bairdii used the same nest materials and constructed their nests in the same manner as *noveboracensis*.

The prairie deer-mouse is equally as unsanitary about its nest as the wood-mouse. Twelve of these animals lived in a buried nest box, the cover of which had caved in, and therefore the nesting material was usually found to be wet each time the nest box was examined, but the mice apparently were not daunted, for they continued to live under these conditions for some time. The prairie deer-mouse did not bring any food into its nest, so far as could be determined.

Apparently, the prairie deer-mouse does not change its place of residence, at least in winter, as frequently as does the wood-mouse. One group of five mice were taken together in October, 1937, and then disappeared until November, 1937, at which time they reappeared with 7 others. The following day only four mice were present, but the following week all 12 mice had returned, and except for two mice which visited another box on one occasion, all these animals remained in the same place at least until the termination of the study on January 29, 1938.

Very few data were secured on the movements of these mice. One mouse which was taken twice was absent on the intervening examination day. Two mice which moved from one box to another travelled a distance of about 150 feet in one night and then came back again during the following week. When these two mice moved the first time, they moved in a direct line from the one box to the other. This was determined by their tracks in the snow.

Male and female *bairdii* were always found together in the same nest, except on two occasions. In the one instance in which several males and females were taken together all the animals were probably related. In October, 1937, five animals were taken, evidently a pair and three offspring. A month later, these five animals reappeared with seven others which were obviously all of the same subadult age. Therefore, it may be assumed that this second group were a second litter of the original parents. This family group of parents and two litters remained together all winter long, except for one young which was probably eliminated by a predator. On March 6, 1938, this box was examined once again and it was found that 10 animals were still there, the original pair and 8 of the younger animals.

An aggregation believed to have been composed of a mixture of *noveboracensis* and *bairdii* was found together in a nest box in the field not far from

the edge of a woods on several occasions. Specimens of these mice were not saved and therefore identification as to species is unfortunately not positive, but it is felt that the field identifications are correct, since I have had considerable experience in handling live specimens of both species.

Discussion

It has been shown by this study that the wood-mouse frequently changes the location of its home. The movements involved in these changes of residence are probably within the normal range of the individual animals. In no instance were two families found living in the same nest box, nor were two families ever found living in different boxes in the same tree or in two boxes in close proximity. This observation is in accordance with the findings of Burt (MS) that each adult wood-mouse has a definite home range which is rarely changed during the breeding season, and that the range of the adult females rarely overlap.

The reasons for changes of residence are not fully understood. The periodic examination of the nest boxes by the observer undoubtedly disturbed the mice somewhat, but evidence has been presented that at least some of the mice were little, if at all, affected by this disturbance.

Th unsanitary condition of the nest after a period of use was probably an important factor in causing the frequent changes of residence. The nests become foul when in continual use. The need for frequent change of nest location is an especially urgent matter for females with young, for these family nests rapidly become unsanitary. Many litters were first moved into the boxes when the young were about 20-25 days of age, but some were younger. This indicates frequent changes of nest sites, especially by females caring for young. The frequent changes of residence by animals permit the nest to dry out between periods of use.

In winter, wood-mice of different ages and sexes frequently live together in the same nest, particularly as pairs, but occasionally in groups of three or more animals. Probably these groups live together for the added warmth afforded by several bodies. It has been observed in the laboratory that, particularly during the winter, all the *Peromyscus* in one cage usually huddle together in one nest. The extra warmth provided by a group must be an important factor in the survival of these animals during severe winter weather.

Also during the winter some nests become flooded or otherwise rendered unfit for occupancy. With this possible reduction in the most suitable nest sites, the mice might find it desirable to live in groups.

Beginning in March and becoming very evident in April, the winter aggregations of wood-mice break up. By the last of April or early May the mice are for the most part living alone, but are occasionally associated in pairs. Burt (MS) finds that some females of this species produce litters as early as the end of March, and that by the middle of April nearly all females have either had one litter or are pregnant.

The breaking up of the winter aggregation and the establishment of individual home ranges is undoubtedly correlated with the onset of the breeding season. It may likely be correlated with the change in the sexual glands leading to sexual maturity. When the sexual instincts are dormant the animals may be assumed not to be antagonistic to one another and they accordingly often live together in winter in small aggregations of mixed sexes. In the season of sexual activity, on the contrary, the animals are mostly solitary.

In the laboratory it has been generally observed that there is a great deal more fighting among adult *Peromyscus* during the breeding season than during the winter. When two adults, in breeding condition, of the same sex, and strangers to each other, are placed together in the same cage, much fighting usually takes place, even if both are placed in a cage which is strange to both. If one adult is placed in the cage of another adult, the stranger will usually be killed. Should several adult females be kept with an adult male in a cage, fighting between the females usually occurs when one of the females becomes pregnant. These difficulties occur less frequently in the non-breeding season.

A female with a very young litter does not tolerate the presence of a male in the same nest (Svihla, 1932). Nevertheless, a female will mate within 24 hours after the birth of her young if a male is present. In nature she must leave the nest for this purpose. In the laboratory the male is forced for several days to occupy a separate nest from that of the young, although his nest may be nearby in the same cage.

Male wood-mice are apparently promiscuous, contrary to Seton's (1920) statement. Males were found in nest boxes with several different females during one breeding season. Also, Burt (MS) has shown that the home range of one male may overlap the home ranges of several females, and that the male probably serves all the females in his range.

Litters of very young mice are always associated with an adult female, presumably their mother. Until just before weaning time, the mother presumably takes good care of her offspring, and probably fights off any intruders, even of her own species, which attempt to enter the nest. Observations in the laboratory both by Svihla (1932) and by the author show that females with newly born young seldom share their nest either with the male or with the members of a previous litter. So little is known concerning the family relations of small mammals that it is impossible to reach any definite conclusions as to why this apparent antagonism is set up between a male and a female which has a litter. It is probably instinctive and seemingly concerned with the protection of the young.

At weaning time (25-30 days) it seems to be the habit of the female wood-mouse to leave the young in the home nest and to seek a new nest for herself and her next litter. At weaning age the young mice are about full size and have probably already been travelling about with the mother for several days (Burt, MS). Whether this sort of behavior is common among small mammals is not definitely known, despite the common belief that animals usually force their young to leave the nest at weaning time. Deserting the young in the home

nest would certainly have its advantages for the young, because they would probably be more or less familiar with the immediate territory about their home. The familiarity with their surroundings probably aids the young in adjusting themselves to an independent life.

Desertion by the female of the young in the home nest and her selection of a new nest for the expected second litter would solve, temporarily, the problem of nest sanitation for the mother, and at the same time relieve her of the encumbrance of the previous brood, allowing her to devote her full time to the rearing of the second litter.

The young, during the summer, leave their nest box within, at the most, three weeks after weaning. The present study does not indicate how far the young travel. It is evident only that the young mice either move out of the territory or are eliminated by predators. As has been indicated, very few juveniles were taken more than three times (or for a maximum period of about 4 weeks) in the area studied.

Adult males frequently become associated with females and their litters just about the time the litter is to be weaned (25-30 days of age). After the female deserts the young, the adult male seldom remains with the litter as a group or with the young males, but he frequently remains associated with a single young female from the litter.

A desire on the part of the adult males to cultivate a new mate is offered as a possible explanation of this behavior. Clark (1938) shows that the average age of the first estrum in *Peromyscus leucopus* is about 46 days, and he records one animal that conceived at 39 days of age. Some of the associations between adult males and young females were of sufficient duration for some of these females to have become sexually mature.

The few notes on dispersal indicate that the wood-mice may travel considerable distances. The greatest distance in a direct line any wood-mouse is known to have travelled, in the present study, is about 1500 feet. This was by an adult male which moved from one woodlot to another during the winter. Most of the mice, however, did not move more than 200 feet from their place of first capture.

A certain amount of inbreeding would be expected in a population of wood-mice which is largely confined to a more or less isolated woodlot. Evidence from the records of individuals associated as pairs in the nest boxes indicate that close inbreeding may occur. Association in the summer between a presumed father and his daughter indicate the possibility of their mating. Associations in the winter between a presumed mother and her sons sometimes persisted long enough into the spring to have resulted in possible matings. Known brothers and sisters frequently remain together long enough to result in possible matings. Although actual proof of inbreeding has not been obtained, the associations which occur between parents and offspring and between litter mates are of a sort which might well result in mating and consequent inbreeding.

So little is known concerning the social relations of the smaller mammals

that it is possible at this time only to make a few comparisons between the social habits of the wood-mouse, as determined by the present study, and those of some other rodents. Vestal (1938) noted an apparent antagonism between male and female wood-rats (*Neotoma fuscipes*) during the breeding season. He states that males and females live alone, although they may live in the immediate vicinity of each other. Vestal noted further that when a female wood-rat with young attached to her teats ran into a house occupied by a male, the male left the house hurriedly. Beaver (*Castor canadensis*), on the other hand, seemingly do not have this sexual antagonism (Bradt, 1938). A male and a female beaver live together in the same house throughout the year. Beaver appear to be monogamous and, unlike the wood-mouse, adults, yearlings, and kits all live together in the same house. Before the birth of the young, the two-year-old beavers are literally "kicked out" of their home, and if they do not leave or can not leave, as in the case of the enclosed animals (Bradt, 1938:159), the two-year-old animals are probably killed.

It then becomes evident that the social life of the wood-mouse compares more closely with that of the wood-rat than with that of the beaver. This is probably to be expected because the wood-mouse is more closely related taxonomically to the wood-rat than to the beaver. It has also been shown above that the social life of the prairie deer-mouse, so far as the observations go, is similar to that of the wood-mouse. These two mice belong to different species of the same genus, and therefore are very closely related.

Summary

Artificial nest boxes placed in the woods and fields and examined at regular intervals have given much useful information about the home life and social habits of the wood-mouse (*Peromyscus leucopus noveboracensis*).

The nest of this mouse in southern Michigan is usually placed in a tree and more frequently near the outer edge of the woods than in the interior of a woodlot. Arboreal nest sites are used slightly less frequently in winter than in summer, and terrestrial nest sites more frequently in winter than in summer.

These mice are very unsanitary in and about their nests. No food was stored in any of the nest boxes. The wood-mouse frequently changes its place of residence, probably in part because of the unsanitary condition which the nest rapidly acquires.

In winter, wood-mice of different sexes and ages may live together. Probably these mice live together in part for the added warmth of several bodies and also perhaps because of a possible scarcity at that season of suitable nest sites. In summer, wood-mice are mostly solitary. The antagonisms between individuals of the same sex and at times between those of different sex are correlated with the onset and development of sexual activity in the spring. In mating habits, wood-mice are apparently promiscuous. Females with very young litters do not tolerate the presence of a male in the same nest. At weaning time, the mother wood-mouse deserts her young, leaving them in the old

nest. An adult male wood-mouse frequently becomes associated with a young female soon after she has been weaned.

The few data available on dispersal indicate that a single wood-mouse may travel as far as 1500 feet, but only a few of the mice moved more than 200 feet from the place of their capture. There is some indication that close inbreeding may at times occur in the wood-mouse population. Field identification of mice indicates the possibility of the wood-mouse and deer-mouse occupying the same nest, at least in winter.

The social life of the prairie deer-mouse, so far as the few observations go, is closely similar to that of the wood-mouse. The type of social life exhibited by these small mammals seems to correspond most closely with that of the other rodents which are closest in taxonomic position.

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